Adaptive Signal Timing for Bicycles

Presented by:
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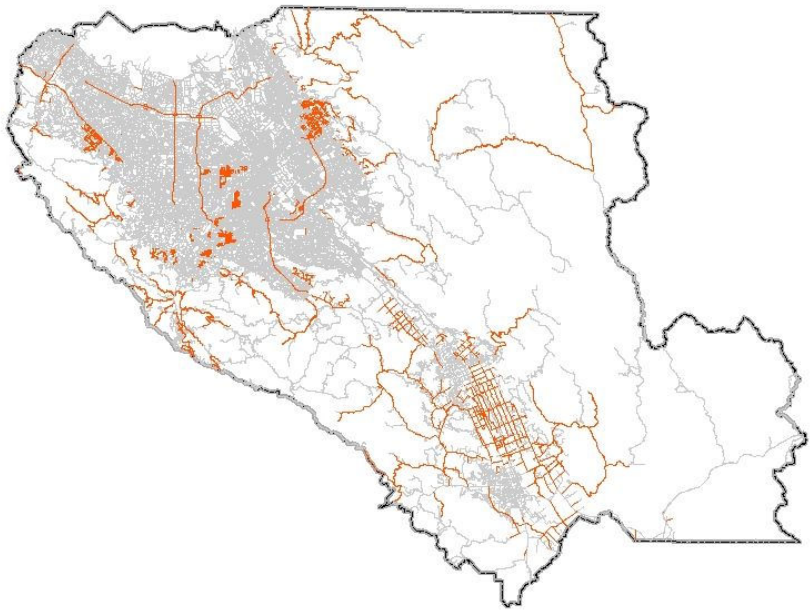
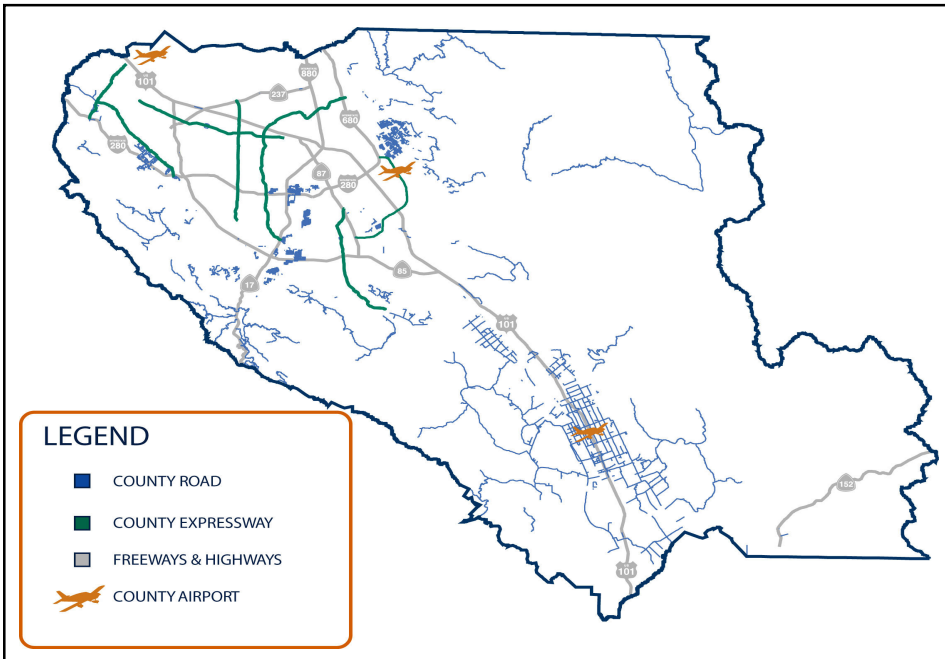
County of Santa Clara
Roads & Airports Department




LEGEND
COUNTY ROAD
COUNTY EXPRESSWAY
FREEWAYS & HIGHWAYS
COUNTY AIRPORT

Background

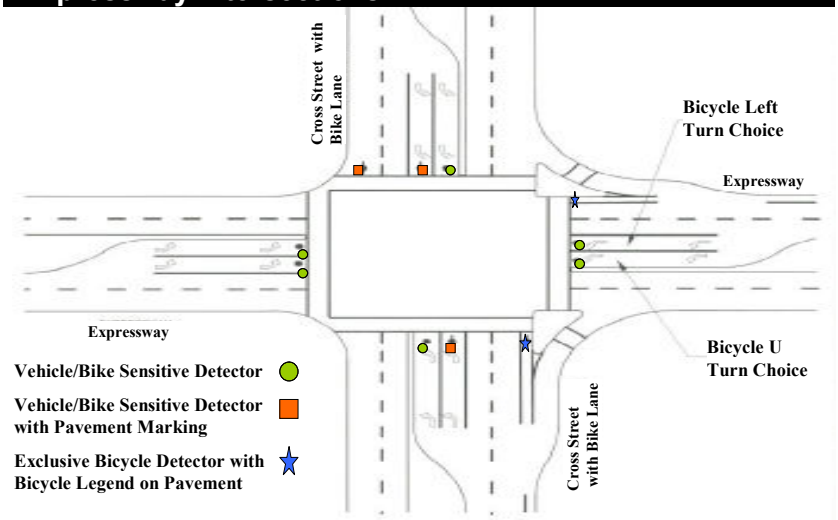
- 1991 - County board policy allowed bicycles on Expressways
- Expressways were modified to accommodate bicycles

Top 10 Bicycle Volume Intersections

(Shading represents intersections with bicycle loops installed)

Expressway	Cross Street	Bicycle Volume (BPH)
Foothill	El Monte	282
Capitol	Senter	225
Foothill	Arastradero	190
Oregon-Pagemill	Bryant	189
Foothill	Magdalena/Springer	181
Oregon-Pagemill	Foothill	150
Central	Moffett/Castro	135
Lawrence	Monroe/Reed	128
Foothill	Grant/St. Joseph	127
Lawrence	Prospect	126

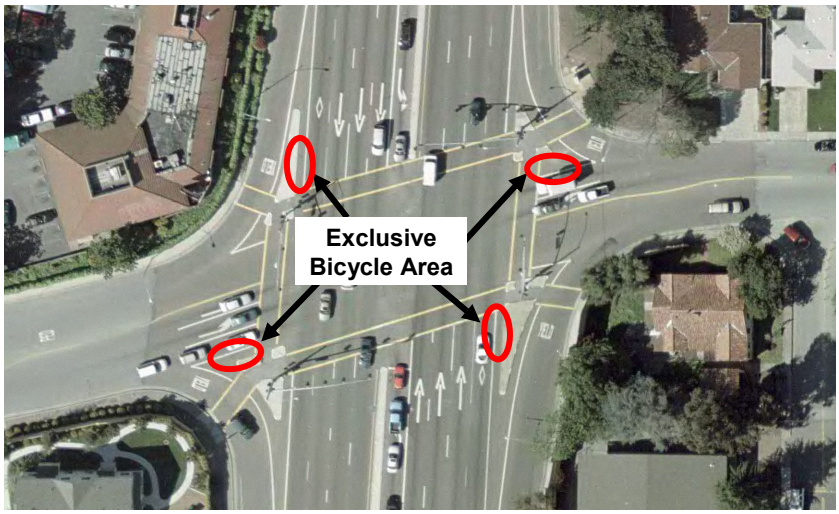
Typical Bicycle Detection Locations & Markings at Expressway Intersections



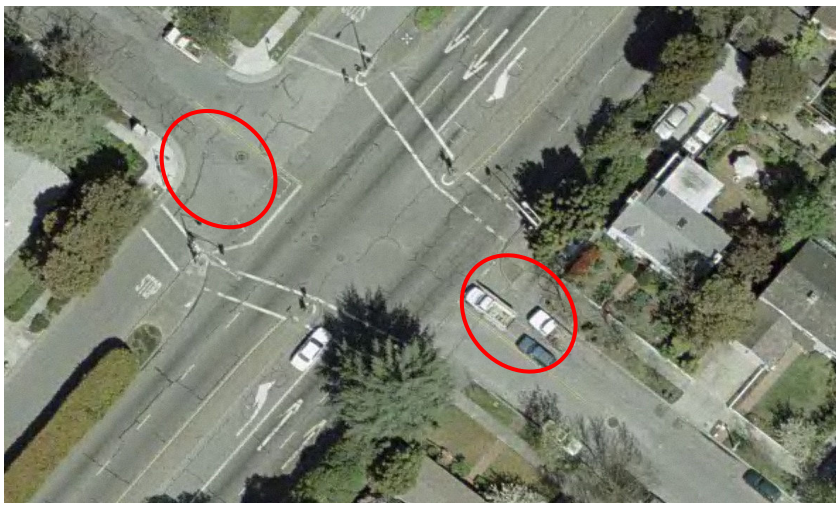
Project Goals

- To provide bicycle specific signal timing at intersections when bicycles are present
- To detect bicycles at intersections including moving bicycles
- Identify 20 intersections for bicycle detection
- Study bicycle/bicyclist characteristics
- Identify traffic signal controller features & limitations to accommodate bicycle timing

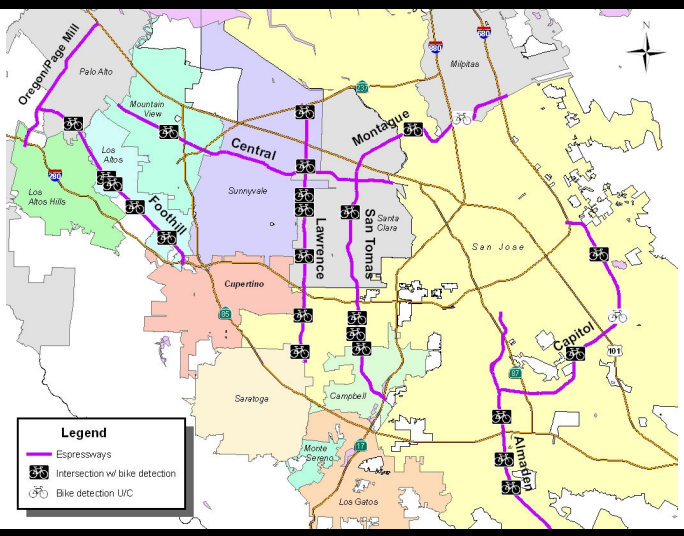
Project Intersection Selection
(candidate intersection with exclusive bicycle areas)



Project Intersection Selection
(not suitable for this project due to absence of exclusive bicycle areas on cross street)

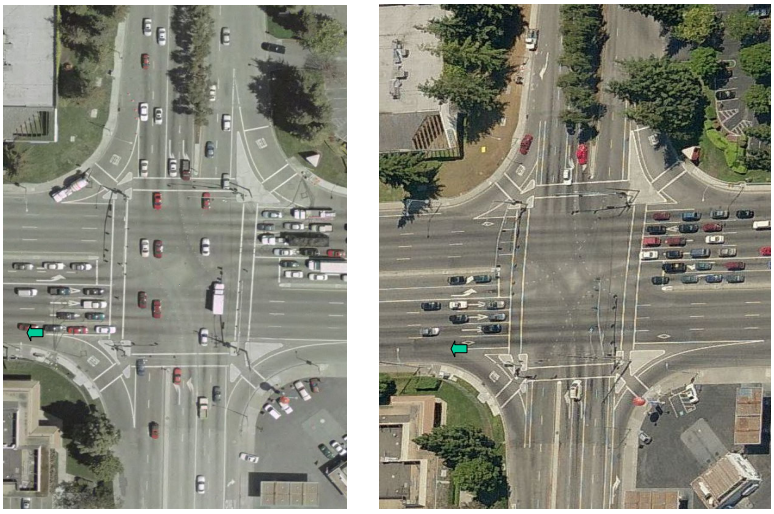


Signalized Intersections with Bicycle Detection



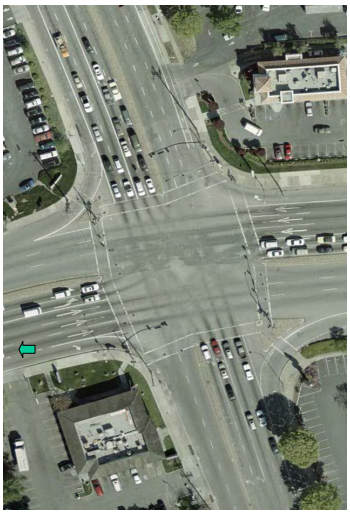
Project Photos

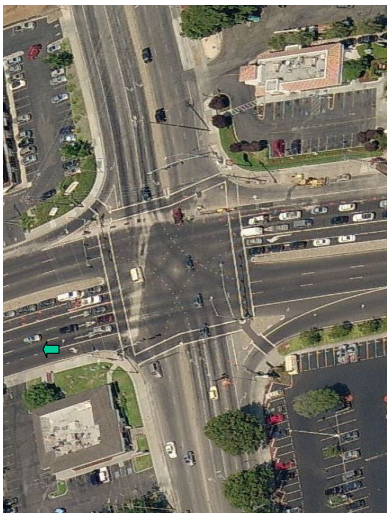
Arques Before After



Project Photos

Branham Before After



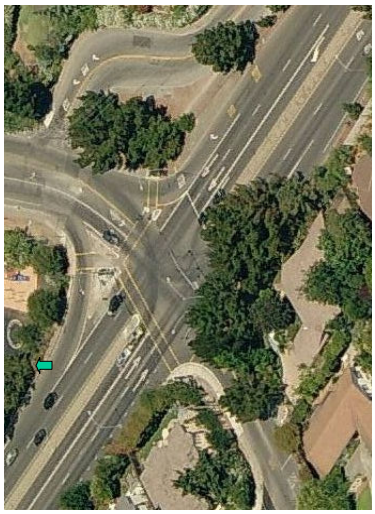


Project Photos

Elko Before After

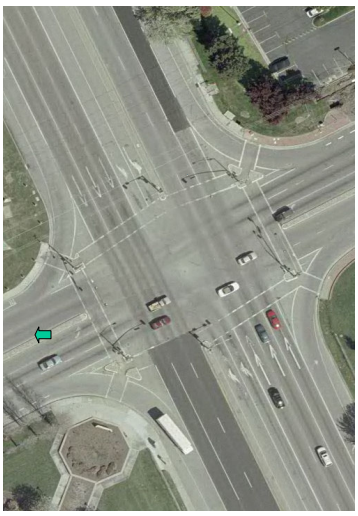
Project Photos

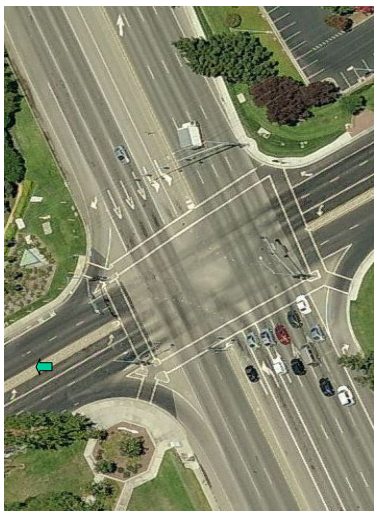
Grant Before After



Project Photos

Zanker Before After

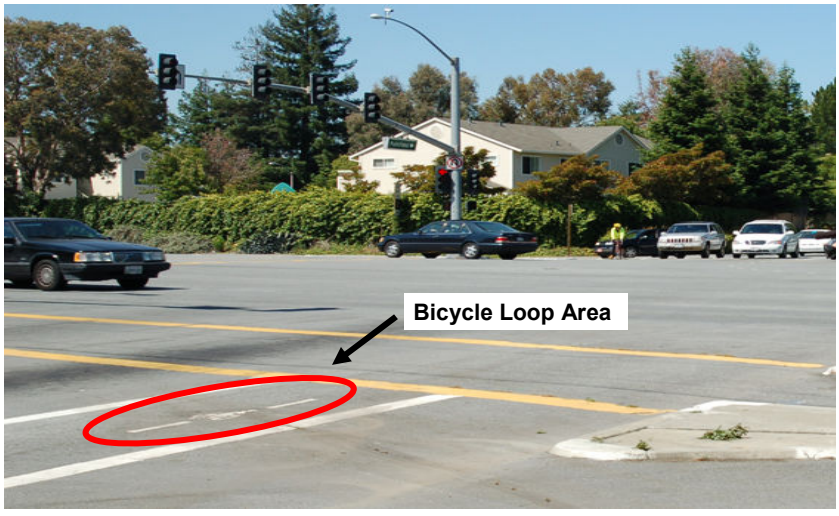




Project Photos

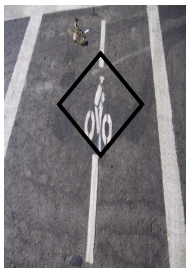
Williams Before After

Project Photos



Bicycle Detection

- Tested video and detector loops
- Loop detectors proved to be highly accurate



Why Special Timing for Bicycles?

- Bicycles are different from motor vehicles
- Relatively low speed
- Need longer green and clearance times to cross at signalized intersections.

Types of Bicyclists

- **Standing Start Bicyclists**
  Bicyclists stopped at intersection before crossing on a green signal

- **Rolling Start Bicyclists**
  Bicyclists crossing an intersection during green signal without stopping (moving bicyclists)

Types of Bicyclist Arrivals

- Arriving at an intersection during **RED**
- Arriving at an intersection during **YELLOW**
- Arriving at an intersection during **GREEN**

Bicycle Speed

	Advanced (ft/s)	Basic/ Typical (ft/s)	Children (ft/s)
AASHTO	17.6	12	9.1
ITE Study[1]	26	18	13
UC Davis	18.57[2]	13.5[3]	--
County Observations	20[2]	12[3]	use crosswalk

[1] By John Forester (3/1995)
[2] 85% speed
[3] Mean speed

Bicycle Signal Timing Calculations

Signal timing parameters are calculated for project intersections with the following assumptions:

Bicycle Length: **6 ft**
Acceleration: **1.5 ft/s²** for an adult bicyclist
Reaction time: **1 second**
Bicycle speed: **8 mph (12 ft/s)**

Bicycle Signal Timing

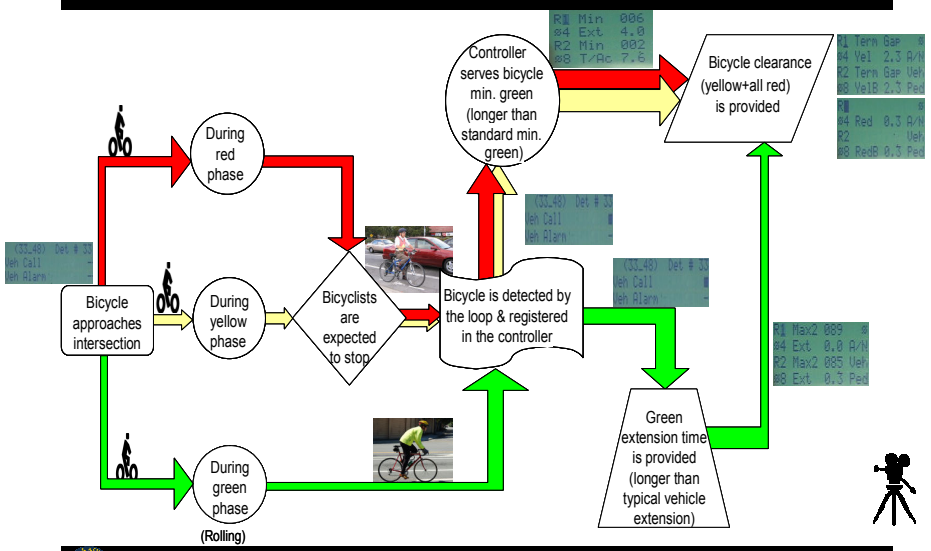
			Min. Green (in sec)		Green Extension (in sec)		Clearance (y+r) (in sec)		All Red (in sec)	
	Expressway	**Cross Street**	SB/WB	NB/EB	SB/WB	NB/EB	SB/WB	NB/EB	SB/WB	NB/EB
1	Capitol	Senter	**10** (8)	**9** (8)	**4** (4)	**4** (4)	**6** (5)	**5** (5)	**2** (1)	**1** (1)
2	Lawrence	Prospect	**13** (8)	**14** (8)	**6** (4)	**7** (4)	**7** (5)	**7** (5)	**3** (1)	**3** (1)
3	Lawrence	Reed	**13** (8)	**13** (8)	**7** (4)	**6** (4)	**7** (6)	**7** (5)	**3** (1.5)	**3** (1)
4	Foothill	Grant	**9** (8)	**9** (8)	**4** (4)	**4** (4)	**6** (6)	**6** (6)	**2** (2)	**2** (2)
5	Foothill	San Antonio	**15** (8)	-	**8** (4)	-	**7** (5)	-	**3** (1.5)	-

( ) Denotes Vehicle Times

Controller Limitations

- Not all controllers support bicycle timing
- Some that support usually provide bicycle clearance only
- Some tweaking is needed to get the bicycle minimum green and green extension to work
- Bicycle detection during yellow does not provide additional clearance, instead, places a bicycle call for next cycle

Flow Chart Showing 3 Scenarios



Conclusion

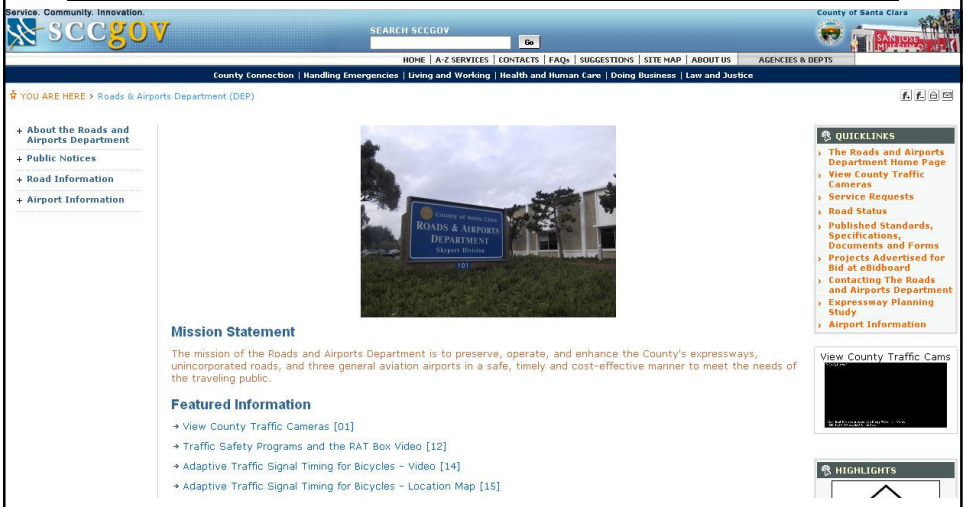
- Bicyclists like pedestrians and motorists need adequate time to cross at signalized intersections.
- With bicycle detection this additional time can be provided dynamically when bicycles are present.
- Inductive loops works well for bicycle detection including moving bicyclists.
- There is a large variation in bicycle speed data; for this project we selected **12 ft/sec** based on AASHTO recommendation.
- Not all controllers accommodate bicycle signal timing.
- Bicycle exclusive areas at intersections are needed to implement this solution.

Project Awards To date….

Next steps…

- Install bicycle sensors at additional expressway intersections
- Educate public/bicyclists of this technology

www.countyroads.org



Questions……

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